REMARKS

Claims 1, 2 and 4-7 remain in the application. New claim 8 presented herein is directed to a process for preparing a single crystal of calcium fluoride having the same features of the crystal claimed in claim 1, namely "a straight barrel part diameter of 17 cm or more, a straight barrel part length of 8 cm or more and a birefringence of not more than 3 nm/cm". Claim 8 requires that the single crystal is pulled from a molten calcium fluoride without subsequent annealing thereof. New claim 9 is directed to a method of producing the crystal of claim 1. Support for new claims 8 and 9 can be found at least at page 7, lines 9-15. No new matter has been added. New claims 8-9 relate to the same subject matter of claim 1; i.e., a CaF_2 crystal produced by single crystal pulling without subsequent annealing to yield the claimed dimensions and low birefringence. Entry and consideration of claims 8 and 9 are respectfully requested.

Claims 1, 2 and 5-7 stand rejected under 35 U.S.C. §103(a) for obviousness over U.S. Patent No. 6,673,150 to Garibin et al. in view of U.S. Patent No. 6,740,159 to Kandler et al. and U.S. Application No. 2002/0166500 to Yogo et al. Claims 1, 2 and 4-7 stand rejected under 35 U.S.C. §103(a) for obviousness over U.S. Application Publication No. 2001/0025598 to Staeblein et al and for obviousness over U.S. Patent No. 6,309,461 to Gianoulakis et al. in view of the Kandler patent.

Applicants respectfully traverse these rejections of claims 1, 2 and 4-7 and assert that claims 8-9 also define thereover for the following reasons.

The present invention relates to the production of calcium fluoride single crystals that are obtained by a single crystal pulling method, the Czochralski method or CZ method. In contrast, the cited references describe a different method of pulling crystals, namely the Bridgman-Stockburger (BS) method and modifications thereof. The BS method involves providing a melt of starting material in a crucible and slowly depressing the crucible. The crystal grows as the crucible is lowered. The cited references only disclose the BS method as summarized below:

- The Garibin patent describes the BS method at col. 1, lines 25-30 and discloses an improvement thereof in the drawings and specification. It does not disclose use of the CZ method.

- Kandler relates only to the BS method; and modifications thereof. See col. 3, line 52 – col. 4, line 4.
- Yogo only relates to the BS method as demonstrated from the drawings and para. [0054] and [0097].
- Staeblein relates only to the BS method and modifications thereof. See para [0035], which also describes a tempering step (comparable to an annealing step) as post-treatment.
- Gianoulakis merely discloses a computer simulation of the BS method.

Moreover, the present application explains at page 2, lines 2-20, that large-size calcium fluoride single crystals have generally been produced heretofore by a crucible depression method, namely the BS method. This method involves use of a melt of a starting material for forming a single crystal in a crucible that is cooled by slowly depressing the crucible containing the starting material to thereby grow a single crystal in the crucible. The BS method produces large internal strains because the crystal is formed in a closed space of crucible. In order to reduce the strain, annealing treatments are used over a period of more than one month after growth of the crystal. Moreover, when a large-size crystal of more than 17 cm is grown, the crystal is partially poly-crystallized.

These drawbacks of the BS method are confirmed from the cited references. In particular, col. 1, lines 57-60, of Gianoulakis teaches that "[c]urrent CaF_2 crystal production methods reliably produce CaF_2 crystals of limited size, because the CaF_2 crystals produced exhibit unacceptably high birefringence at sizes over about 6 inch diameter". Similarly, Staeblein teaches at para. [0012] that "no satisfactory uniformity can be attained with sufficient yield with the known methods".

Despite attempts to overcome these deficiencies of the BS method, the BS method cannot produce a crystal having birefringence as low as 3 nm/cm. In support of that fact, Applicants submit herewith a copy of Sumiya et al., Hitachi Chemicals Technical Report (No. 43, July, 2004), "Large-Size CaF_2 Single Crystal for Next-Generation Lithography Lens", pages 19-24 and a partial translation thereof. This article describes production of large sized CaF_2 single crystals by the BS method. As indicated in Section 2.1 and Fig. 1, the crystals produced via a BS method are impure and exhibit undesirable polycrystalization. The article also discloses in Section 4 that low-stress growth technology can be utilized to

reduce internal stress, distortion and birefringence. However, even by the use of this low-stress growth technology, the resulting CaF_2 single crystal has a birefringence of at least 6 nm/cm. See Fig. 8 on page 23. This reference clearly demonstrates the fact that a single crystal of CaF_2 in the as-grown state produced by a BS method cannot satisfy the requirement of a birefringence as low as 3 nm/cm, even as recently as the year 2004 with the benefit of technology developed to reduce birefringence in CaF_2 crystals produced via a BS method.

Accordingly, none of the cited references could result in a non-annealed crystal having the claimed birefringence. Therefore, claims 1, 2 and 4-7 that require a crystal produced via a pulling technique without annealing to achieve the claimed dimensions and low birefringence define thereover.

New claims 8 and 9 also define over the cited references for similar reasons. Both claims are directed to a method of producing a single crystal of CaF_2 via a crystal pulling technique (not via the BS method) to achieve the claimed dimensions and low birefringence. Nothing in the cited references teaches or suggests practicing a crystal pulling method to obtain the claimed dimensions and low birefringence.

Accordingly, claims 1, 2 and 4-9 are believed to define over the cited references and be in condition for allowance.

Respectfully submitted,

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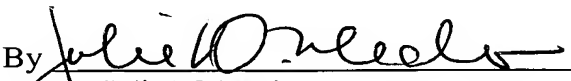
By 

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